Manufacturing

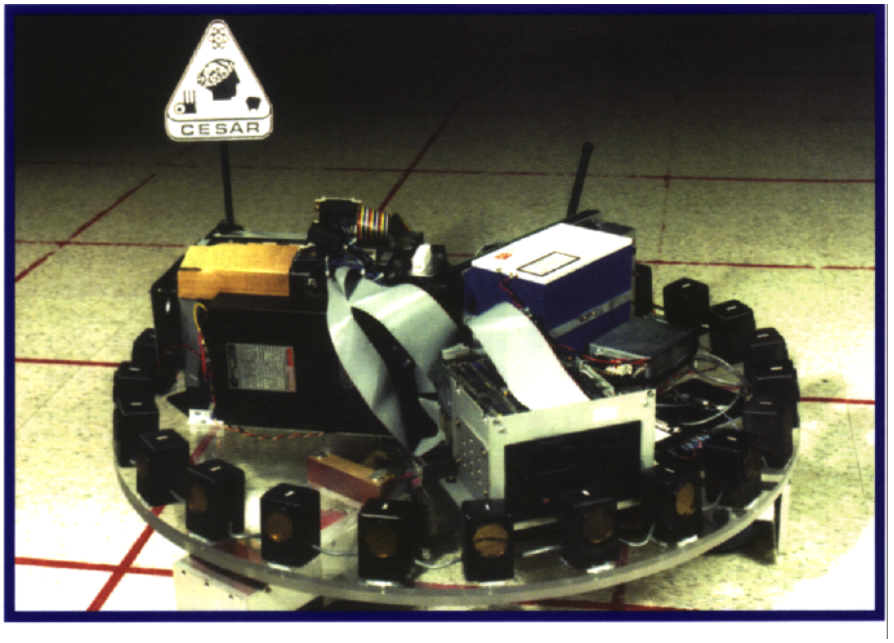
science for advanced manufacturing technologies

A manufacturing revolution is under way. Today, effective manufacturing is concerned not only with low-cost and high-quality products, but with maximizing energy efficiency, minimizing pollution, and ensuring our safety and health. The current buzzwords include "life cycle engineering," "computer-aided design," "intelligent manufacturing systems," "integrated manufacturing system," and "concurrent process/product design." Underpinning all of these are process models, sensors, and fundamental technologies that come from basic research.

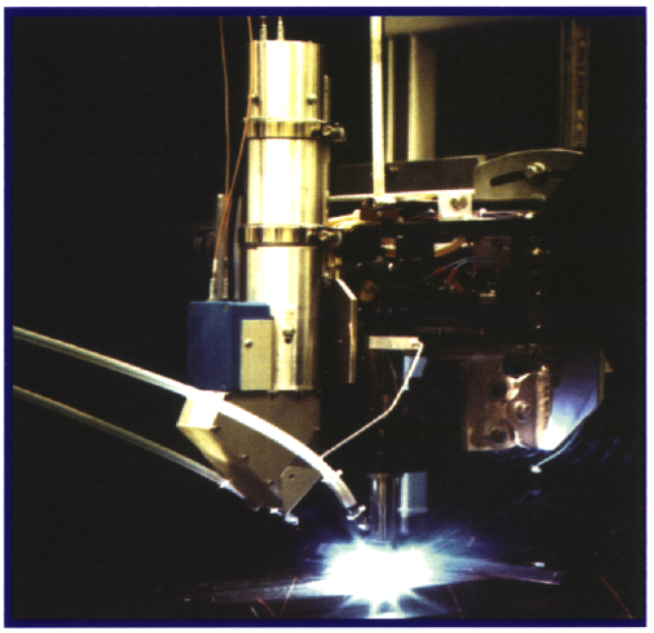
The ultimate goal is to design both the product and the manufacturing process on a computer, thereby eliminating much expensive trial-and-error prototyping and retooling of assembly lines. Understanding manufacturing well enough to simulate it on a computer requires complex models that incorporate accurate data from every step of the process. BES is a leader in developing intelligent sensing and models for thermal and deformation processing. Industry is incorporating these scientific tools in a wide range of manufacturing procedures, from welding and heat-treating to rolling sheet metal and fabricating complex shapes.

Reduction of scale is another challenge in today's manufacturing environment. Electronic devices are fabricated on the micro- (or even submicro-) scale, where circuit components have features that are one hundred times smaller than the diameter of a human hair. Micromachines are being used more and more, such as on heads that can read ever-more-dense information on computer disks and in small sensors that monitor temperatures. Manufacturing these small devices requires elaborate techniques and advanced characterization for quality control. BES user facilities have served as partners with industry in developing these tools.

Concern for personnel and for the environment is also central in today's manufacturing world. To this end, robotic systems are increasingly used in hazardous environments. BES is developing the advanced systems and software needed to advance robotics to meet the needs of the next century.



Robotics — automated machines — are heavily used in a host of manufacturing processes. The BES-funded Center for Engineering Systems Advanced Research (Oak Ridge National Laboratory) has developed a new type of platform for mobile robots called the Omnidirectional Holonomic Platform. This invention, which received an R&D 100 Award, has stimulated nearly 100 inquiries from industry. The platform is currently being upgraded for commercialization through a collaboration with Nomadic Industries.

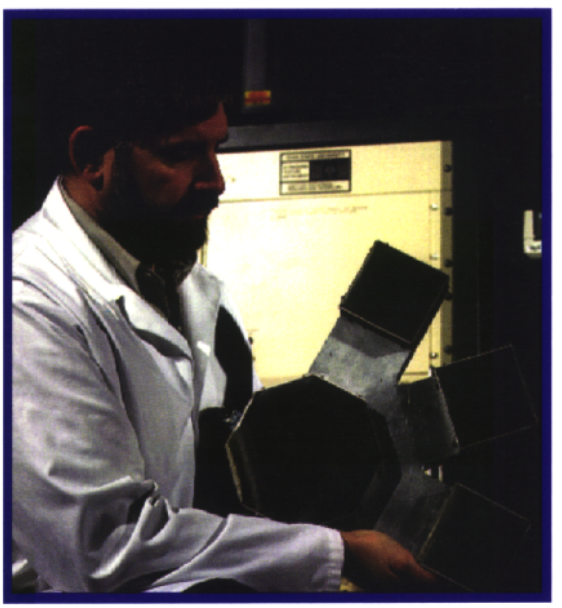


Visualizing Welding

Welds are used to join metals in virtually all manufactured products. The laser-assisted welding vision system, developed at Idaho National Engineering Laboratory, provides significantly clearer images of the molten metal pools during welding than are possible with conventional video cameras. These images can be used for quality control diagnostics and computer control of the welding equipment, which results in higher quality welds. A spin-off company, Control Vision International, is in its sixth year of producing and marketing this system to the arc-welding and plasma spraying industries.

Nondestructive Inspection

Tearing is a major concern in manufacturing components made from thin metal sheets (such as beverage cans or automobile parts). The Ames Laboratory multiviewing ultrasonic system (shown here) is being used to nondestructively inspect sheets to detect flaws during processing. Several industries, including aluminum companies, automotive companies, and steel producers, are collaborating to develop this technology.



Micromachining

Both the scientific community and private industry are excited about the potential of micromachining technologies. The thermal sensor for automobile engines (shown here) was formed by deep-etch X-ray lithography at the Advanced Light Source, Lawrence Berkeley National Laboratory. This technique can produce robust micromachines that are simultaneously thick (1 mm) vertically and thin (μm) horizontally. Lawrence Berkeley, which is collaborating with Jet Propulsion Laboratories, is using this technique to fabricate precision devices used in X-ray astronomy.